CANADA
DEPARTMENT OF AGRICULTURE
EXPERIMENTAL FARMS SERVICE

DOMINION FOREST NURSERY STATIONS

INDIAN HEAD, SASK.

JOHN WALKER, B.Sc., M.S., SUPERINTENDENT

SUTHERLAND, SASK.

W. L. KERR, B.S.A., M.Sc., SUPERINTENDENT

PROGRESS REPORT 1947-1952

TREE PLANTING WAS STARTED ON
THIS MANITOBA FARM IN 1906

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QUEEN'S PRINTER AND CONTROLLER OF STATIONERY
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INTRODUCTION

During the past six years tree planting activities associated with P.F.R.A. programs have been included among special projects for purposes of record, supervision and assistance. These include:—Field Shelterbelt Associations, Community Pastures, Water Developments, Co-Operative Farms, and Pre-development Farms.

Demand for trees for farm planting in the Prairie Provinces remains at a high level. Since more and more farmers are operating their farms from residences in town or city, home shelterbelts are becoming less necessary, and the present trend is towards the planting of field shelterbelts. Distribution of evergreen trees has been significantly stepped up.

By the purchase of an additional quarter-section of land in 1950 the station at Indian Head now comprises 640 acres.

The effect of increased use of 2,4-D sprays and dusts for the control of weeds in grain fields has been reflected on shelterbelt trees. Reports of damage to trees, particularly to boxelder, are received at Forest Nursery Station offices each year. Apparently damage occurs even when 2,4-D has been used at a greater distance than one-half mile from the trees.

In 1947 two divisions of Research were established. "Tree Breeding" is directed by W. H. Cram, and "Tree Physiology" by J. Wilner. Accomplishments in these divisions are reported on pages 31 to 40 of this report.

During 1947-48 a new greenhouse 25 by 50 feet, and a utility and tree storage building 48 by 84 feet were constructed at Indian Head. Construction work at Sutherland included the building of a root cellar, barn, implement shed and work shop, auditorium and tree storage cellar, greenhouse, and several other smaller units. There is now good tree storage accommodation for 5,000,-000 trees. These facilities help greatly for early and delayed shipping of trees when outside weather conditions may not be favorable. The storage cellars also permit more rapid handling of trees in the fall as well as at shipping time in the spring.

As an economy measure appropriations to permit the employment of Tree Planting Supervisors have been greatly curtailed.

After 28 years of service as Forest Assistant, H. W. Lennox died on September 6, 1948. D. A. Macdonald, Forest Assistant, retired on superannuation on April 9, 1949, after 36 years of service. J. B. Thomson retired from the position of farm foreman on March 4, 1949, having been employed in that capacity since March, 1919. C. A. Edwards, Assistant Superintendent, retired on September 21, 1950, having served with the station for 41 years.

DISTRIBUTION OF TREES

The distribution of trees and cuttings for shelterbelt and hedge planting on farms in the Prairie Provinces continues to be the chief function of these Forest Nursery Stations. Production aims and distribution objectives are often upset by late spring frosts, drought, diseases and pests, and excessive seasonal moisture.

Pests requiring the application of control measures were: grasshoppers in 1947; pine leaf scale, aphids and blister beetles in 1948; grasshoppers in 1949; tent caterpillar, pine leaf scale, larch sawfly, red spider mite, Colorado potato beetle, and grasshoppers in 1950; aphids, tent caterpillar, Colorado potato beetle, and larch sawfly in 1951 and pine needle scale, red spider mite, aphids, Colorado potato beetle and larch sawfly in 1952.

FIGURE 1—*Upper*: Superintendent's residence, Dominion Forest Nursery Station, Indian Head, Sask., showing early plantings in 1905. *Lower*: Appearance of residence in 1951.

Table 1.—Trees Distributed 1901—1952

Item	Man.	Sask.	Alta.	Others[1]	Total
Broadleaf Trees	34,556,308	143,926,061	56,792,586	45,041	235,329,996
Evergreen Trees (begun in 1910)	1,078,315	3,807,704	1,573,300	15,094	6,479,913
Total	35,644,623	147,733,765	58,366,386	60,135	241,809,909

[1] Not designated until 1947.

How Trees May Be Obtained

Important facts about the free tree distribution policy of the Government of Canada follow:—

1. Broadleaf trees caragana, ash, boxelder (Manitoba maple), elm, in almost unlimited number, and limited numbers of willow and poplar, are available for planting on bona fide farm property FREE of charge, express charges COLLECT.
2. For evergreen trees, white spruce, Colorado spruce, Scots pine, there is a charge of $1.00 per 100, express charges COLLECT. For any one planter in any one year a minimum of 50 trees and a maximum of 200 evergreen trees will be supplied.

Note:—Broadleaf and evergreen trees are NOT shipped together.

3. Application forms for trees for farm planting are available from The Forest Nursery Station, INDIAN HEAD, Sask. When applications are accepted and allotments of trees are made, planting plans are prepared and provided for the guidance of planters.
4. Trees will NOT be supplied unless planters have well-summerfallowed ground ready for them. Instructions on planting of trees and care on arrival are supplied to planters.

Promising selections of poplar and willow, and young trees of Siberian elm, have been provided in limited numbers for test planting. Many war veterans on Veterans Land Act farms and small holdings have planted trees in the period covered by this report. In most years the demand for planting material of broadleaf and evergreen trees has exceeded available supplies.

Table 2.—Trees Distributed 1937-1952 (Inclusive)

Year	Broadleaf		Evergreen	
	Planters	Trees	Planters	Trees
1937–1946 (annual average)	5,139	5,162,150	1,217	191,600
1947	5,025	5,445,225	1,309	201,797
1948	5,699	6,245,648	1,949	255,180
1949	5,685	6,322,986	1,936	293,128
1950	5,528	5,494,035	1,473	223,657
1951	5,292	6,470,025	1,567	250,118
1952	5,180	7,041,760	2,002	298,083
Annual Average	5,501	5,836,616	1,699	255,327

Range of starting and finishing shipping dates at Indian Head for the six-year period was April 18, (1952) to April 30, (1951), and May 12, (1950) to May 22, (1948), respectively. An annual average of 19 refrigerator cars were required to accommodate trees shipped. To assist and guide tree planters, an annual average of 2,335 planting plans were prepared. On these plans established plantings were shown, planting to be done was detailed, and future plantings in relation to buildings, etc., were suggested.

Occasionally it is necessary to transfer material from Indian Head to Sutherland and vice-versa. Transfer from Indian Head to Sutherland was necessary in the spring of 1950 because during 1949 practically no rain fell on parts of the Sutherland station. Transfer has been successfully made by refrigerator railroad car, and by truck-trailer, without packing and baling. The latter method is most convenient.

It is gratifying to note from the annual averages given in Table 2 that interest in farm tree planting is being sustained at a satisfactory level. Tree planting throughout the region has undoubtedly been stimulated by assistance provided to planters by Provincial Governments and by municipal authorities, especially where organizations or groups of planters have been formed at the local level under the direction of the Agricultural Representative or the District Agriculturist.

The unanimous opinion among tree planters is that control of snow movement, protection, and the aesthetic value of trees are important benefits of farm tree planting.

As indicated in the introductory paragraph a significant trend in farm tree planting has been toward the planting of field shelterbelts. Visible effects and results obtained from plantings in the Conquest, Sask., and other Field Shelterbelt Association areas, have, no doubt, stimulated increased interest in field shelterbelt planting. No small factor has been the availability of tree planting machines. Plantings that may also be considered of a specialized nature are included in Table 3.

Table 3.—Trees Distributed for Specialized Plantings
(included in statistics of Table 2)

Plantings (1947–1952)	Number of planters	Number of trees	Average number of trees per planter
Field Shelterbelts	1,909	7,379,075	3,865
Churches and Cemeteries	145	116,565	803
Dams and Dugouts	141	104,780	742

It is interesting to observe that the first item in Table 3 represents the planting of over 2,096 miles of a single-row hedge at a spacing of 18 inches between trees in the row. Such a development as this cannot fail to improve conditions throughout the prairie region from both the aesthetic and productivity standpoint. Some of this planting has, without doubt, been designed for roadside protection. A generally reduced interest in the development of dams and dugouts on farms during the past few years has been reflected in the number of trees distributed for this type of planting. The present trend is towards the development of community dams. Plantings for such developments, as well as for churches and cemeteries, represent local community effort.

Continued support has been given by Forest Nursery Stations to the roadside protection project sponsored by Good Roads authorities in Manitoba. Between 1947 and 1952 (incl.) a total of 591,962 trees, mostly broadleaf, were

FIGURE 2—*Upper*: Superintendent's residence, Dominion Forest Nursery Station, Sutherland, Sask., showing early plantings in 1916. *Lower*: Appearance of residence in 1950.

supplied for hedge planting along highways in Manitoba. This quantity is sufficient for planting over 37 miles of hedges each year, with plants set two feet apart.

Table 4.—Trees Distributed for School Planting

Year	Manitoba		Saskatchewan		Alberta	
	Trees	Shipments	Trees	Shipments	Trees	Shipments
1937-1946 (annual average)	16,806	33	59,753	73	26,935	27
1947	5,325	7	33,200	39	14,075	16
1948	2,725	5	32,825	51	13,325	14
1949	2,825	6	29,600	50	10,600	18
1950	13,550	20	20,700	44	13,125	22
1951	7,075	11	48,750	57	9,225	10
1952	11,300	14	44,097	44	17,950	13
Total	42,800	63	209,172	285	78,300	93
Annual average	7,133	10	34,862	47	13,050	15

School and education officials at the local and provincial level do the spade work in the promotion of tree planting at schools. Through this type of co-operation responsibility is shared and sustained interest is maintained. Loss of rural population and closing of rural schools limit this potential sphere of tree planting.

PERMANENT PLANTATIONS

From 1904 to 1913 a number of permanent plantations were set out at Indian Head. Later, plantations were established at Sutherland, based largely on results from early plantings at Indian Head. Introduced species were included in these plantations as well as native species. Various associations of species were adopted. In the intervening years a number of plantations have been modified or removed entirely. It has become clear that evergreen species, some introduced, show superiority to broadleaf species from nearly every standpoint, e.g., relative hardiness, rate of growth, longevity, protective value, and year-round attractiveness. For example, plantations, set out in the period already specified, containing the following species were discontinued and cleared out for one reason or another before 1943: white willow; golden willow; acute-leaf willow; tamarack and boxelder; silver maple; acuteleaf willow and cotton-wood; Norway spruce and caragana; white birch and boxelder; red pine, ash, caragana.

Since 1943, plantations containing the following have been discontinued and cleared out: white birch and boxelder; cottonwood and boxelder; acute-leaf willow and boxelder; green ash and boxelder; Russian poplar and boxelder; tamarack and boxelder. On the other hand, plantations continuing to make vigorous growth and in healthy condition contain the following species or association of species: tamarack and spruce; white spruce and Scots pine; Scots pine; white spruce; American elm and green ash; Scots pine (and ash); European larch and ash; tamarack and ash; tamarack; lodgepole pine and ash; Scots pine (and boxelder); Colorado spruce (and caragana); jack pine (and caragana); Colorado spruce (and boxelder); Siberian larch (and boxelder); white spruce (and boxelder).

Brackets in a number of the above items mean that the species has been removed or is periodically pollarded to ground level. In most instances where the species in alternate rows has been removed under-planting with the remaining species has been proceeded with. During the five years under review practically all caragana, where planted in alternate rows with other species, has been removed. At close range caragana has restricted the development of other species. The reverse is true of caragana plants manifesting the "pendulant" habit of growth since these apparently exert a beneficial effect on trees planted in adjacent rows.

Space does not permit giving growth or yield data for all remaining plantations. The policy being followed is to remove a minimum of material so that information on survival and ultimate development may represent the maximum that might be expected. During the period under review development in these plantations has been very satisfactory.

White spruce appears to be the most desirable species to use for under-planting, whether the original planting contained broadleaf or evergreen species. This has been forcibly demonstrated in a number of plantations at Indian Head, particularly in plantation 8.

Average rates of growth of various tree species in pure stands have been regularly recorded at the Indian Head Station since the initial plantings were made. Table 5 shows the height and diameter growth of various evergreen tree species that may be expected in woodlot plantations on upland, prairie clay loam soil, without the benefit of irrigation.

Table 5.—Development of Evergreen Species

Species (variety plots)	Age in years	Average height in feet	Average diameter in inches D.B.H.)
Balsam fir	44	42·50	6·81
Douglas fir	42	29·25	6·12
Siberian fir	39	31·92	4·87
Dahurian larch	21	31·83	3·77
European larch	43	49·67	9·71
Japanese larch	43	32·42	8·00 (8 trees only)
Siberian larch	43	49·42	8·54
Tamarack	43	43·25	7·00
Bull pine	38	32·67	5·76
Jack pine	44	38·00	5·77
Lodgepole pine	43	34·67	5·39
Limber pine	40	27·33	5·08
Red pine	41	40·00	11·9 (7 trees only)
Scots pine (Finland)	27	27·00	4·01
Scots pine (German)	43	38·08	7·93
Scots pine (Rigensis)	38	28·67	5·77
Scots pine (Russian)	38	34·75	6·08
Scots pine (Scotch)	38	40·33	7·63
Swiss stone pine	45	29·66	4·73
White pine	38	53·53	5·69
Black Hills spruce	44	41·42	6·93
Colorado spruce	43	36·25	5·61
Norway spruce	42	41·25	6·17
White spruce	44	43·17	6·57

The figures show that evergreen trees may produce profitable returns over a period of years when once established. Little may be expected from a new plantation until after twenty years, but by making a proper choice of species substantial returns may ultimately be expected. By means of irrigation yields may be speeded up and increased.

In order to determine their suitability for untrimmed hedges or field shelterbelts, plants of a number of shrub and small tree species were planted

Photo at 3. (Upper) Survival and development of 34-year-old Scots pine ... competition with caragana in adjacent rows 4 feet apart. (Lower) Siberian larch planted in 1912 average height over 38 feet, average d.b.h. about 8 inches. (Country Guide Photo)

at Indian Head in 1946. These included such well-known species as American mountainash, Amur maple, cherry prunsepia, common seabuckthorn, European red elder, golden currant, late lilac, Manchu cherry, pygmy peashrub, Russian olive, silver buffaloberry, tatarian honeysuckle, tatarian maple. Lesser known species tried included black hawthorn, Chinese bushcherry, flowering plum, ground cherry, Japanese plum, Manchu walnut, Manchurian crabapple and Ussurian pear. As at October, 1951, average height ranged from 11.5 feet (tatarian maple) to 3.5 feet (pygmy peashrub) in the former group, and from 8.5 feet (Manchurian crabapple) to 3.5 feet (Chinese bushberry) in the latter. The "suckering" habit which characterizes such species as common seabuckthorn, ground cherry and buffaloberry is somewhat objectionable.

Species that have succeeded as hedges at Sutherland are: Alta Scotch rose, common choke cherry, Hansen hedge rose, pin cherry, Preston and other

FIGURE 4.—Measuring Scots pine in Plantation 22

hybrid lilacs Siberian currant Fruits of a number of hedge plants are valuable as winter food for birds and other wildlife. Details of studies conducted on belts containing different standard tree species at various spacings in the row are included in the Tree Physiology section of this report prepared by J Wilner

The following table shows the estimated average height of species at various spacings and arrangements in the three-row belts All were planted in 1943 with the exception of two, namely 8 by 4 feet and 16 by 4 feet, which were planted in 1945 In all belts caragana occupies the north row and ash the south row The arrangement of species in middle rows is shown by letters B, boxelder E, elm, C, cottonwood Belts are separated by a cultivated strip 16 feet wide

As would be expected, development of the more recently established belts is considerably below that of the earliest planted ones, for all species, except American elm in the 8- by 4-foot spacing

Additional information has been secured on development of trees planted at varying distances from established trees These were planted as three-row belts in April, 1943 with caragana occupying the west row ash and elm alternated in the east row and boxelder ash, boxelder elm planted in that sequence in the middle row Spacing in rows was 12 inches for caragana and 4 feet for other trees, rows were spaced 4 feet apart

Table 6.—Development of Species in Shelterbelts.

Height in Feet

Spacing	Caragana	Boxelder	Green ash	American elm	Cottonwood
4 by 4 E.B.E.C.	9.4	3.83 ([illegible] dead)	[illegible] dead	12.39	[illegible] (5 dead)
4 by 4 [illegible] E.B.E.C.[illegible]	[illegible]	14.[illegible]	[illegible]	12.49	[illegible] (4 dead)
8 by 4 B.E.B.C.	8.4	11.4	7.84 (4 dead)	12.84	11.83 (13 dead
8 by 8[1] E.B.E.C.[illegible]	10.36	14.54 (1 dead)	10.24	14.84	18.3[illegible] (1 dead
16 by 4 B.E.B.C.[illegible]	[illegible]	44	9.23	[illegible] dead	14.3 (8 dead)
16 by 1[illegible] E.B.E.C.	[illegible].41	15.[illegible]	11.23	15.86	[illegible]

[1] Average of two belts—November 20, 1951 [illegible]

FIGURE 5—Seeds may be secured easily with the three-section extension ladder

Table 7.—Development of Trees Planted EAST of Established Trees

(West Side Plantation 23)

Distance from established trees (in feet)	Average Height in Feet November 16, 1951					
	West Row	Middle Row			East Row	
	Caragana	Boxelder	Ash	Elm	Ash	Elm
9	8 4					
13		17·25	8·8	13 1		
17					2 94 (1 dead)	15·44
18	11·23					
22		17 29	9·83	14·1 (1 dead)		
26					11 53	16 25
27	11 47					
31		17 26	10 0	13 36		
35					12·0	13 0
Average		17 27	8 46	13·69		

Table 8.—Development of Trees Planted WEST of Established Trees

(East Side of Plantation 23)

Distance from established trees (in feet)	Average Height in Feet—November 16, 1951					
	East Row		Middle Row			West Row
	Ash	Elm	Boxelder	Ash	Elm	Caragana
9	2·58 (3 dead)	1·67 (11 dead)				
13			10·7	5·36	4·92	
17						10·46
18	12 14	13·0 (1 dead)				
22			14·5	10·5 (2 dead	10·4 (2 dead)	
26						11 0
27	12 16	15·35 (3 dead)				
31			15·62	10·92 (1 dead)	16·0 (1 dead)	
35						11·4
Average			13 61	8 93	10·64	

In Tables 7 and 8 average heights are given for three species planted in middle rows, because they indicate that protection given by established trees on the west side seems to have been beneficial to the development of the trees, ash being an exception. From these tables also it will be seen that caragana developed more strongly at nine feet from established trees than ash and elm,

that ash developed better with less mortality than elm under similar competition, and that a new belt may be expected to develop satisfactorily if planted 18 feet from established trees.

In 1945 a test was begun at Indian Head in which various plants were set out in an area, part of which was known to be highly impregnated with salts. These alkaline locations were readily delineated because of light-colored precipitate on the soil surface. Average height of plants, as at October 10, 1951, and numbers of plants measured in both normal and alkaline soils are presented in the following table

Table 8.—Development of Species as Influenced by Soil Alkalinity

Species	Alkaline soil			Normal soil		
	Height in feet	Number of plants		Height in feet	Number of plants	
		Living	Dead		Living	Dead
Silver buffaloberry *Shepherdea argentea*	7 89	16	2	8·43	38	
American mountainash *(Sorbus americana)*	7·00	4	14	9·65	30	7
Russian olive[1] *(Elaeagnus angustifolia)*	8·70	14	4	10·94	35	1
Siberian salt tree *(Halimodendron halodendron)*	5 86	18	—	7 18	38	
Common seabuckthorn *Hippophae rhamnoides*	4 40	15	3	6·00	33	3
Siberian elm[2] *(Ulmus pumila)*	9 23	11	7	10 67	26	10
Villosa or late lilac *(Syringa villosa*	3 50	4	14	5 07	34	4

[1] 16 3% of living plants manifest winterkilling.
[2] 67 6% of living plants manifest winterkilling.

During the test survival has been highest in Siberian salt tree, silver buffaloberry, Russian olive, and common seabuckthorn, particularly where alkali is present in the soil. Of these Russian olive and silver buffaloberry appear to be the most suitable where a taller hedge or wind barrier is wished, and Siberian salt tree and common seabuckthorn for a hedge of medium height.

Beginning in 1942 a comprehensive test of poplar species, hybrids and selections has been steadily expanded For some selections 5-row plots of 85 trees each were established. For the majority the test row contained 17 trees. Spacing in all cases was 6 feet between trees and 12 feet between rows. At the end of 1951 there were 120 selections under test.

Forty-two selections apparently unsuitable for extensive distribution and planting because of incidence of canker, unsatisfactory vigor or lack of hardiness, were removed. Final recommendations concerning newer poplars must await further study

FARM SHELTERBELTS

Approximately 100,000 farm units in the Prairie Provinces have been supplied with trees by Forest Nursery Stations. Trees have been planted in shelterbelts around buildings and gardens, in fields or near dugouts. Protection is the chief function of the plantings with control of snow movement, returns in fuel, and aesthetic value of secondary importance. Of the remaining farm units established in the Prairie Provinces it is estimated that around 75,000 are located in areas where there is natural tree growth and that approximately 75,000 would benefit from tree planting in some form or another. Present design of farm shelterbelts recommended by the Department is one consisting of about four rows of broadleaf and one or more separate rows of evergreen trees. Arrangement of rows and trees may be as follows:

First row (outside)	Caragana 1 foot apart
Second row	Boxelder, elm, boxelder, poplar in that order, at 4 feet apart OR Elm, boxelder, elm, poplar in that order—at 4 feet apart
Third row	same as second row
Fourth row (inside)	Ash alone or ash and elm planted alternately at 4 feet apart
Fifth row	Evergreens at 4, 6, 8 or more feet apart—this row to be separated from the fourth row by a cultivated strip 12 to 20 feet wide. Planting of evergreens should be postponed until one or two years after the broadleaf trees are established

FIGURE 6—Farms like this illustration can be seen throughout the former treeless prairie region.

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FIGURE 7. Accumulated snow near field shelterbelt. North of East [illegible] Ness hedge

FIGURE 8—Strong growth of oats between hedges at Sutherland

In low areas or areas of plentiful moisture willow may be substituted for caragana. In some areas also the order of planting in the second and third rows may be boxelder, ash, elm. Where dense shelter is wished the spacing indicated between trees in the row, namely caragana one foot, others 4 feet, is considered desirable. Planters wishing to cultivate between tree rows with tractor cultivator may space rows accordingly. However, to obtain dense shelter in the shortest possible time after planting, and reduce to a minimum the amount of cultivation needed, the rows should be spaced from 4 to 6 feet apart. From the outset a most important detail in shelterbelt management is to maintain, in permanently cultivated condition, margins *outside* tree rows up to 16 or more feet wide.

Frequently planters suggest that evergreens at 4 feet apart are too close together in the row. For the development of specimen trees this is true, but not where year-round shelter is wished. Two rows of spruce planted at Indian Head about 40 years ago with trees from 3 to 4 feet apart in the rows provide the evidence. Height of trees is between 40 and 50 feet. Width of belts is about 24 feet. In the respective rows around 85 per cent of the trees originally planted are growing strongly.

SPECIAL CO-OPERATIVE PROJECTS

Projects formerly carried on under P F R.A. and administered by this Station were absorbed into Forest Nursery Station organization in 1948. At that time full-time staff members were R. H. Dunlop and Miss A. L. Smiley. In 1947 all special projects, including Field Shelterbelt Associations, and others organized under P F R A. had been placed under the direct supervision of Mr. Dunlop. This plan seemed desirable in order that his wide experience in prairie tree planting might be utilized in the promotion of specialized tree planting projects.

A few of the more important specialized tree-planting projects are: community pastures, municipal projects, co-operative farms, community dams and those connected with water development projects. Assistance to these projects has included advice on tree planting plans and problems, and planting material supplied. In the promotion of tree planting on prairie farms university students have been employed as seasonal supervisors.

Phases of the work which Tree Planting Supervisors can discuss with planters are: proper soil preparation, correct planting procedure, species adaptability, importance of cultivation, control of pests, care of evergreens, renovation of unthrifty belts, value of field shelterbelts, best location and pattern for future plantings. For the new planters an opportunity to discuss these matters may mean avoiding disappointment and difficulties later.

Field Shelterbelt Associations

Four field shelterbelt associations were approved under P F R.A. in 1935, to be located at Lyleton, Man., Aneroid and Conquest in Saskatchewan, and Porter Lake, Alta. They were organized by groups of farmers to determine, if possible, the economic and practical value of field shelterbelts. These farmers agreed to subdivide their farms by planting suitable hedges and tree belts with the object of controlling soil drift, reducing wind damage and retaining a maximum portion of winter snow on the land.

Table 10.—Trees Distributed to the Conquest Field Shelterbelt Association

Year	Number of Shipments	Number of Trees (included in Table 2)
1947	56	524,775
1948	53	309,225
1949	47	284,355
1950	52	274,400
1951	48	182,925
1952	39	101,325
Total	295	1,676,005
Annual Average	49	279,334

In 1946 the size of the Conquest Field Shelterbelt Association area was increased from 63 to 126 square miles. This represents 80,640 acres. Early-planted hedges are now well established, and the average height of those that have been given ideal care and management, as at the end of 1951, was as follows

one row	caragana	10 5 feet
one row	caragana with other trees* at intervals	12 0 feet
two rows	caragana	10 5 feet
three rows	caragana, ash, boxelder (one row each)	17 0 feet

*these may be green ash, American elm or boxelder

There are 161 names on the Conquest inspection list, and 533 miles of hedges.

NOTE. Within recent years less than 30 miles of hedges have been removed to permit provincial highway and municipal road construction. New planting is being done to replace hedges removed.

Table 11.—Trees Distributed to the Lyleton Field Shelterbelt Association

Year	Number of Shipments	Number of trees (included in Table 2)
1947	12	32 400
1948	34	168,350
1949	33	141 425
1950	39	102,925
1951	16	48,400
1952	28	60,275
Total	152	547 275
Annual Average	25	91 212

In 1947 the size of the Lyleton Field Shelterbelt Association area was increased from 42 to 72 square miles. This represents 46,080 acres. Early-planted hedges have developed well, and the average height of those which have been given ideal care and management, as at the end of 1951, was as follows:

one row	caragana	9·6 feet
one row	boxelder	18 0 feet
one row	caragana with other trees* at intervals	16 0 feet

* these may be green ash boxelder American elm willow in low-lying locations has grown 27 feet.

There are 103 names on the Lyleton inspection list, and 303 miles of hedges. In the years under review soil moisture has been plentiful in the Lyleton area, almost excessive for the best development and survival of caragana.

Table 12.—Trees Distributed to the Aneroid Field Shelterbelt Association

Year	Number of shipments	Number of trees (included in Table 2)
1947	2	900
1948	2	18,725
1949	15	226,635
1950	17	178,650
1951	26	190,850
1952	22	168,225
Total	84	782,975
Annual Average	14	130,496

In 1949 the size of the Aneroid Field Shelterbelt Association area was increased from 30 to 144 square miles. This represents 92,160 acres. Progress of planting in the new area has been considered satisfactory. Early-planted hedges are well established, and the average height of those that have been given adequate care and management as at the end of 1951, was as follows:

one row ... caragana* ... 8 5 feet

* a few isolated plantings of boxelder, but only in most favorable locations has this species developed stronger than caragana, namely, 2 to 3 feet taller.

There are 203 names on the Aneroid inspection list, and 132 miles of hedges. Survival in hedges planted in 1949 was extremely low because of severe drought, and nearly all were replanted the following year.

Table 13.—Trees Distributed to the Porter Lake Field Shelterbelt Association

Year	Number of shipments	Number of trees (included in Table 2)
1947	5	6,480
1948	5	7,050
1949	6	10,485
1950	5	8,000
1951	—	—
1952	—	—
Total	21	31,985
Annual Average (4 years)	5	7,996

No change has been made in the size of the Porter Lake Field Shelterbelt area, of 25 square miles or 16,500 acres. This area was widely planted in the 4-year period 1937 to 1940. Early-planted hedges are well established, and the average height of those that have been given adequate care and management, as at the end of 1951, was as follows:

one row ... caragana ... 10 5 feet

two and three rows caragana—and various associations of green ash, boxelder, American elm ... 19 0 feet (overall)

There are 47 names on the inspection roll, and 28 miles of hedges. In the Porter Lake region the need for providing protection against wind influence is less acute than in the three other association areas. Moisture efficiency is also much higher

In the 1950 and 1951 planting seasons a tree planting machine, designed at Indian Head, was used by Mr Dunlop at Aneroid, Conquest, and Lyleton In 1952 the tree planting machine was used at Conquest and Aneroid Planters supplied tractor power and labor required The first model of this machine was tested in June 1948 Modifications were made on the planting machine as the need arose This planting machine was demonstrated at Conquest on May 24 1950, to members of P F R A Advisory Committee Blueprints are available from the Engineering Division Experimental Station Swift Current, Sask

A maintenance allowance of $15 per mile granted to members of field shelterbelt associations for five years after field shelterbelts are planted, was increased to $20 in 1949. In the same year Departmental policy provided that trees for planting in field shelterbelt association areas would be shipped by express prepaid Each year a number of planters in field shelterbelt association areas fail to give their shelterbelts sufficient care, particularly marginal cultivation, to qualify for full maintenance allowance Factors contributing to this condition include lack of labor pressure of seasonal work excessive moisture when trees should be cultivated illness, and indifference Departmental policy of continuing maintenance payments for five years would seem to be fully justified because significant benefits cannot be realized until after that time The value of field shelterbelts in reducing soil drifting and improving conditions generally for agriculture may not be fully recognized or appreciated until relatively dry and hot seasons are again experienced Inconvenient blocking of roads by snow in winter is also prevented by properly planned field shelterbelts

While the planting arrangement of trees in field shelterbelts may be modified occasionally by planters, *Caragana arborescens*, Lam planted in a single row is the predominant species used When spaced from 12 to 18 inches apart in the row caragana plants quickly provide protection at the soil surface against wind erosion and as development takes place their protective influence across fields becomes significant The practical operation of keeping single rows cultivated and free from weeds as compared with multiple rows, is extremely important

FIGURE 9. Added weight is provided by snow in field shelterbelt

Figure 10. Cultivation delineated by moving fence into field shelterbelt

Figure 11. Note well-cultivated margins of young poplar field shelterbelt

Figure 12—Double row caragana shelterbelt 12 feet high.

In recent years a popular modification of the single row of caragana has been to substitute a boxelder American elm or green ash for caragana at intervals of 4, 6, 8, 10 or more feet Sometimes also double rows of caragana are planted as field shelterbelts. Occasionally a planter has included three rows of trees in his field shelterbelts Although north to south orientation of belts is recommended, topography and convenience have been taken into account when advice has been given to individual planters

Resulting from a more widespread use of tree planting machines in recent years the trend in planting field shelterbelts is to alternate at 18 inches apart in a single row, caragana and a tree of another species, boxelder green ash, or American elm With planting machines carrying two men the planting of alternate species in the row is easy because each man is responsible for handling only one kind In such plantings caragana provides protection at ground level while the taller growing trees add height to the belt

In all four projects the width of fields between belts varies from 20 to 40 rods depending on the type of soil its topography and its tendency to drift The interest of the individual farmer is a potent factor not only in the extent to which field shelterbelts are planted but also in the degree to which the belts are cared for

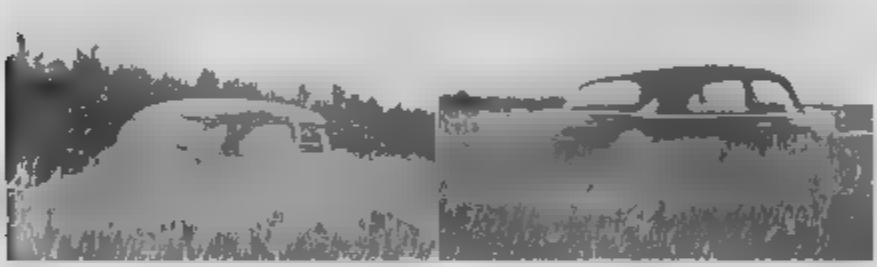

FIGURE 3. Perceptible difference in height of Durum wheat in field at Aneroid near hedge *(left)* and in centre of field *(right)*

Snow Accumulation as Influenced by Field Shelterbelts

From data secured at Conquest during the winters of 1946, 1947 and 1948 the following statements seem justified While the amount of snowfall wind direction and wind velocity all influence the distribution and depth of snow in any given area, it would appear that the pattern of snow accumulation is very similar from year to year for any given type, arrangement and system of field shelterbelts In two of three years two-thirds to three-quarters of the volume of the snow accumulated on the west side of north to south hedges and belts In the case of east to west belts the greater proportion of snow was held on the north side It has been observed that the final disposition of a great deal of snow trapped by field shelterbelts is dependent upon the last strong windstorm of the winter season.

While it is too early to evaluate these field shelterbelts, there is no question about the feasibility of establishing them provided proper methods of planting cultivating and care are followed Preliminary studies have been made on the effect of field shelterbelts on crop yields In this connection protection to crops against mechanical injury by wind is an important function of field shelterbelts From yield data secured from well protected fields in these association areas, there is evidence that increases in wheat yields will result from efficient shelterbelt protection. This increase may be very significant

In 1949 the study of field shelterbelt influence was developed on a project basis under the direction of Dr P O Ripley Chief Field Husbandry Division, Central Experimental Farm, Ottawa, with the following co-operating agencies Soil Research Laboratory Swift Current, Sask Experimental Farm, Brandon, Man , Experimental Stations at Scott and Swift Current Sask and Forest Nursery Station, Indian Head Sask A summary report containing the findings of the Forest Nursery Station on field shelterbelt influence, over a period of nine years was prepared in 1949 by R H Dunlop

Community Pastures

There are 59 community pastures on the inspection list Following visits to these a report is prepared containing suggestions as to the best location and type of tree planting for each unit When considered desirable a planting plan accompanies the report A copy of the report is forwarded to P F R A , Regina, as well as to the community pasture manager Trees are allotted as required As improvements in pasture headquarters sites and buildings develop, plans often need modification To date planting plans have been prepared for over 40 units, and planting has been proceeded with at 35 of them. Planting has been concentrated at pasture headquarters Most pastures are located in relatively dry areas, and at some there is an abundance of sub-surface moisture Visits are not made to every pasture each year An annual average of 15 shipments, containing 9 256 broadleaf and evergreen trees, have been distributed to community pastures during the 1947-1952 period

Mortlach Afforestation Project

A quarter-section of land, NW 26-17-1-W3, Soil Survey type between Sand and Hatton Fine Sandy Loam—has been set aside by R M of Wheatlands No 163, Mortlach, Sask for this project The project was initiated in 1945 when 8 290 broadleaf and 2,175 evergreen trees were planted From experience and experiment in this area the best methods of soil preparation prior to planting, and soil management afterwards, are being determined Information secured on tree growth in this project will be of value in planning for tree planting in other areas where soil conditions are similar As at the end of 1952 29,960 broadleaf and 10,060 evergreen trees had been planted No trees were set out in 1948 and 1951 because when planting could have been done conditions did not favor a reasonable survival Early season planting is essential on soil of this type Keeping in mind the danger of soil drifting, sufficient soil preparation to kill persistent weeds before trees are planted, and tillage between rows afterwards are necessary In 1947 and 1948 weed growth around individual trees was also destroyed A covering of straw has been effective in stabilizing blow-out areas. Scots pine, spruce, boxelder and poplar show most promise Development of established trees continues to be satisfactory

Supervisory advice and service, along the lines indicated for special projects previously listed, and planting material as required, were provided for others as follows (trees supplied in 1953 are included)

Community dams constructed by P F R A at Assiniboia, Cadoux Ceylon, Coronach, Davidson, Tyvan	134,750 trees
Co-operative Farms at Carrot River, Fairview, Matador, Meskanaw, Sturgis	62,088 trees
Kincaid Afforestation project (Saskatchewan	148,750 trees
Melita Reclamation Station	3,845 trees
P.F.R.A. Depot, Moose Jaw and Pre-development Farm, Outlook	7,864 trees
Rush Lake Water Users Association	6,126 trees

Some supervision and advice were also given to around 35 active groups mostly organized by agricultural representatives or municipal officials for the purpose of planting trees for roadside protection.

Kindersley Afforestation Planting

No planting has been carried out in this project since 1946. Development of Scots pine trees established on the NE 1-30-24-W3 between 1936 and 1946 continues to be satisfactory. When trees are established on this type of soil and the roots penetrate to a soil depth where sub-surface moisture is plentiful, normal development of trees and the production of cones may be expected. On a long-term basis evergreen trees are expected to be much longer-lived and give an ultimate yield far in excess of most broadleaf trees.

RODENT CONTROL

Almost every year tree planters are faced with the problem of preventing rodent damage to trees and fruit plants, especially when they are small. Co-operative studies, involving measures to combat and eliminate this hazard, have been carried on for a number of years by the Sutherland Station. The following observations are based on these studies.

Rabbits

Bush rabbits, jack rabbits, and cottontails may become serious pests, where there are certain kinds of trees and shrubs and when they are small or the snow is deep. This has been especially so in many areas where the local coyote control program has completely eliminated their most common enemy. Caragana, boxelder and spruce are less susceptible to attack than most other species. The use of a rabbit-proof fence is usually confined to only a small garden or orchard area. It should be kept in good repair and high enough to prevent snowdrifts blowing over it. Box traps have been found to be satisfactory for controlling cottontails. Carrots or apples make good bait. Bush and jack rabbits are taken more readily in an open trap. This is a tent-shaped cage with wood or metal ends and bottom, and with sides of wire netting. For jack rabbits it should be approximately 36 inches long, 30 inches high and 30 inches wide at the bottom. A trap about two-thirds this size is large enough for bush rabbits or cottontails.

A sliding trap door 10 by 12 inches is made at one end. The pan (or platform) should be about 12 inches square and attached to the bottom by the front end with a hinge. The other end is connected to the trigger by means of a flexible wire through a staple or screw eye in the top of the cage. Rabbits are attracted to the location by means of oat sheaves, straw or hay, etc. A little straw or hay is scattered around the outside and inside of the trap. A handful of oats or wheat is placed on the straw over the pan. Some alfalfa or green oats may be placed in the far end of the cage. When the rabbits enter the cage their weight on the pan releases the trigger and the trap door comes down behind them.

Bush rabbits in particular and all rabbits in general soon make well defined runways to and from their favorite feeding places. Snares set along these runways are usually effective in controlling rabbits.

Well organized rabbit drives, or hunting with shotgun or rifle, are perhaps the quickest and most effective control measures. If one takes advantage of certain existing conditions such as no snow when rabbits are white or early snowfall before they are white, the pests are very conspicuous. Rabbits are also easily destroyed during the early morning or evening while they are feeding. Good dogs add greatly to the effectiveness of hunting.

Rabbits migrate long distances and tend to congregate in very large numbers where there is some protection and a good food supply It is, therefore, important to extend control measures to the surrounding area, commence them early and continue them throughout the year, if possible.

Field Mice

The short-tailed field mouse is the most widespread and destructive pest of garden, orchard, lawns and even of shelterbelts. They feed not only on grass, vegetables, small fruits and the bark of fruit trees, but will also eat many perennial and annual flowers or may girdle rather large trees. The most serious and most noticeable damage is done to trees, shrubs, perennials and small fruits under a covering of snow The damage is frequently not observed until it is too late to adopt control measures.

Gopher poison placed in small tin cans on their side under a sheaf of oats or forkful of straw has been found effective in controlling field mice. The containers should be placed about 25 to 50 feet apart around grassy or weedy areas and along hedges or shelterbelts. It is important that the poison be placed out before there is much snow and that it be replenished when necessary Careful inspection of plantations should be made when the snow is disappearing in the spring. If there is any evidence of mice, more poison may be put out and timely repair measures adopted.

Repellents

If only a few rodents are present they may be prevented from doing serious damage to trees and shrubs by the use of repellents. If the animals are very abundant and desirable food is scarce or if there is danger of heavy migration, repellents may not be effective Rabbits may be forced to migrate by heavy snowfalls. Mice may also migrate if their feeding grounds freeze following a mild spell. Some repellents are very toxic to buds, twigs or bark of certain kinds of trees and serious damage may result from their use A repellent that has been found to be fairly effective and safe may be made by mixing rosin and alcohol Two pounds of powdered rosin are mixed with one (imperial) quart of denatured alcohol (antifreeze) Cheap grades of both are satisfactory This can be applied with a brush or sprayer to twigs and bark.

Pocket Gopher

Under certain conditions, the pocket gopher may become one of the most serious pests of gardens, lawns, forage crops and golf courses, etc Pocket gophers make extensive burrows, unsightly "push-ups" and damage the roots of many plants, including trees. They may be easily controlled by the use of traps, poisons, or gas.

The main runway of the gophers can be located by testing the ground with one's heel or the use of an iron rod. It usually runs at right angles to the "push-up ' and a foot or two to one side—the concave side, or where the last earth has been pushed out in plugging the hole Use the most recent "push-ups" For trapping, dig a hole and remove loose earth on both sides of the main runway to make room for the trap to work The trap (a number 0 or 1 gopher trap) is set and a board put over the hole Some earth is then put around and over it to keep the runway absolutely dark

For poisoning, cubes made from apples or carrots and treated with gopher poison or white arsenic are usually effective when placed in the runway Holes must be plugged after poisoned bait is placed in the runway

Another quick and effective method is to connect a hose to the exhaust pipe of a car or tractor and place the other end of the hose fairly tightly in the runway, then run the engine for a few minutes and plug the hole.

HORTICULTURE

Horticultural activities at Forest Nursery Stations are intended primarily to demonstrate that worthwhile lawns, flower borders, vegetable gardens, and fruit plantations may be developed on prairie farms when efficient shelter is provided. Plantings include commonly-grown and recommended, tree and bush fruits, herbaceous perennials and annual flowers, perennial and annual vegetables suitable for home gardens and quite extensive collections of hardy ornamental trees and shrubs. Forest Nursery Station gardens often escape damage by late spring frosts and early fall frosts that injure garden crops in the surrounding district. Efficient shelter is considered to be an important factor in this circumstance.

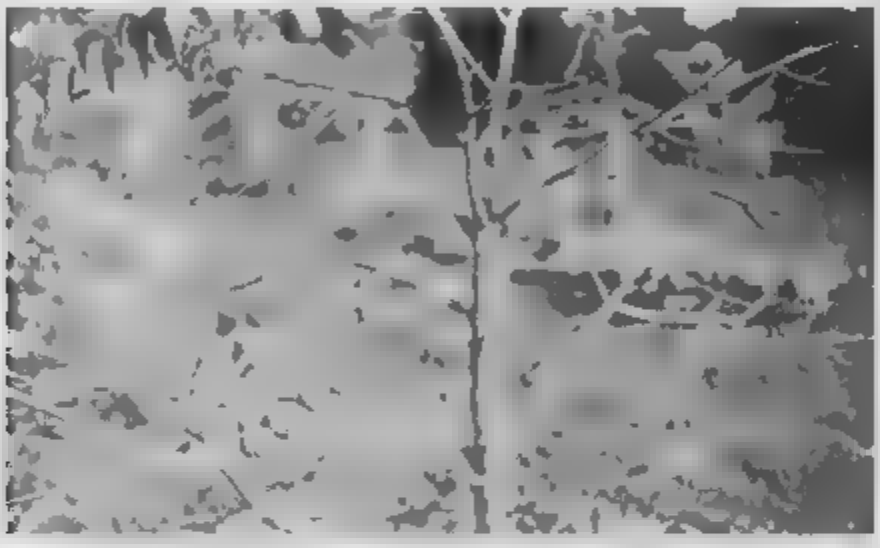

Figure 14. Fruits on black walnut planted ten years.

Figure 15—Slough hay mulch applied to smaller perennial flowers.

FIGURE 16—Visitors at Sutherland may average nearly 10,000 during a week from May to September

Fruits

A few varieties of fruits succeeding at Forest Nursery Stations that deserve special mention are —

Apple	Battleford, Heyer 12, Melba, Wealthy
Apple × Crab	Kerr 0-235, Rescue, Trail
Crabapple	Amur, Bedford, Columbia, Dr. geo, Florence, Robin
Plum	Bounty, Dandy, Mina, Norther, Pembina, P 7 (M-125?), Tilda
Sandcherry × Plum	Dura, Heaver, M 119, Manor, Opata, Sapa
Cherry	Ground cherry seedlings, Manchu cherry seedlings
Black Raspberry	Honeywood
Red Raspberry	Chief, Latham, Madawaska, 0-163 (Tweed?), Ruddy, Viking
Strawberry (everbearing)	Gem, Pixie, Sparta
Gooseberry	Pixwell

Vegetables

With vegetables the aim is to demonstrate how a suitable selection of varieties kinds may be produced throughout the year for home use, including easily-stored kinds for winter use. Development of vegetables is very satisfactory in the protected sites used. For example, at Indian Head first harvest of asparagus and rhubarb has been made as early as April 30 and May 6, respectively, (in 1949). For some annual vegetables early outdoor sowing is practised. Seeds of beet, carrot, lettuce, parsnip, peas and radish are usually sown during the third week of April. Successive sowings follow as required. Beans, corn and cucumber are usually sown around the middle of May. Beet, carrot, and rutabaga, intended for winter storage, are sown during the first week of June.

Specific varieties of beans, cabbage, corn, peas, and tomato that are early-, medium-, and late-maturing are grown to yield returns throught the season. Outstanding varieties of certain vegetables are:

Cabbage	Copenhagen Market, Danish Ballhead, Golden Acre, Penn State, Red Acre
Corn	Dorinny, Golden Bantam, Marcross, Spancross, Sugar Prince
Onion	Early Yellow Globe, Prizetaker, Sweet Spanish
Tomato	Bounty, Early Alberta, Early Chatham, FNS 45-9, Meteor, Mustang
Potato	Bliss Triumph, Canus, Quick Lunch (early), Warba.

Ornamental Trees and Shrubs

At each station new hedges planted to protect fields and plots contain various species of trees and shrubs. Species that produce edible fruits for wildlife in fall and winter have been favored. In this group are included:

American mountainash, bur oak, Chinese bushberry, choke cherry, European red elder, hawthorn species, highbush cranberry, Manchu cherry, pin cherry, rose species, rosybloom crabapple, sandcherry, wild plum.

For a pruned hedge the following broadleaf species are highly recommended:

Amur maple, cherry prinsepia, common and hybrid lilacs, European cotoneaster, Peking cotoneaster, Poiret barberry, pygmy peashrub (caragana), sweetberry honeysuckle. Evergreens suitable for a hedge in the prairie garden are: Colorado spruce, eastern white cedar (hardy strain), Scots pine, Siberian fir, white spruce.

Black walnut trees planted in 1940 have yielded fair crops of nuts since 1948.

In the arboretum established at Indian Head in 1942 the visitor has an opportunity to compare different species in various genera. The arboretum and adjacent plantings contain specimen woody plants of 75 genera and 300 species. These represent a majority of useful ornamental shrubs and small trees. No attempt has been made to include specific varieties or selections of particular species, e.g. varieties of common lilac. Each species is represented by one or more plants. Species belonging to the same genus are adjacent for convenient comparison.

Genera by which a number of valuable and interesting species are represented include:

Acer, Berberis, Caragana, Cornus, Cotoneaster, Euonymus, Juniperus, Lonicera, Potentilla, Prunus, Ribes, Rosa, Sorbus, Spiraea, Tilia, Viburnum and Ulmus.

Outstanding species deserving of mention are:

Aesculus glabra, Cotoneaster melanocarpa, Forsythia ovata, Physocarpus opulifolius, Quercus macrocarpa

Additional experience has been gained in producing seedlings of a number of ornamental shrubs and trees, and in carrying them over in the nursery.

A promising new shrub represented by prairie almond, is being developed from the cross *Prunus triloba* × *Prunus pedunculata*. Second generation seedlings from this cross are generally hardy and very ornamental when in bloom. Seedlings vary considerably in vigor and produce an abundance of blossoms which vary in color from very pale to deep pink. Blossoms also vary from singles to extreme doubles.

Flowers

Because many individuals as well as organized groups visit these stations during the summer months, bright showings of flowers are planned throughout the season. These include annuals, biennials, and perennials. Lawns and picnic facilities are maintained for the pleasure and comfort of visitors. A large sports field, an auditorium and a small collection of animals and birds are maintained at Sutherland.

At Sutherland extensive plantings of dahlias, delphiniums, hardy chrysanthemums, and lythrums provide colorful displays in season. Annual flowers, such as marigold, petunia, snapdragon, stocks and zinnia, and a wide variety of herbaceous perennial flowers, including perennial phlox, contribute to the display of bloom at Indian Head. Tulips in a wide range of colors, and *Scilla sibirica*, open the flower season, the latter in late April or early May. These are followed by early-flowering perennials such as Iceland poppy, iris, bleeding heart, globe flower, lupines, peony, columbine, oriental poppy, lily, lychnis, delphinium, daylily and pyrethrum. Hardy fall-flowering perennials such as border chrysanthemums, herbaceous spireas, ligularia, lythrum, monkshood, michaelmas daisies, and perennial phlox are particularly valuable. Annual and other flowers usually conspicuous in Forest Nursery Station gardens are celosia, Coltness and decorative dahlias, dianthus, gladiolus, geranium, hollyhock, marigold, petunia, snapdragon, stocks, sweet peas, tuberous begonia, and zinnia.

PUBLICITY

Publicity towards more extensive tree planting is secured by correspondence and personal contact, through press articles and the living testimony of well developed shelterbelts scattered over the prairie region of Western Canada. Names of prospective tree planters are frequently forwarded to Indian Head and Sutherland by interested farm organizations and by municipal and government authorities. A few statistics covering this phase of Forest Nursery Station activities follow. Annual average 1947 to 1952, inclusive (Indian Head figures only)—press articles 12, popular and scientific papers, 5, meetings, field days, etc., 20, pieces of mail received, 18,543, pieces of mail sent out, 33,753, active files set up, 2,476, seminar papers given (4 years only) 4.

TREE BREEDING

W. H. Cram, Plant Breeder

C. G. E. Brack, Plotman

Since the commencement of the Prairie Tree Planting program in 1901, great advances have been made both in the selection of adaptable tree species and in nursery practices. In 1947 a plant breeder was engaged for a tree improvement program and in 1949 the tree breeding staff was doubled by the addition of a plotman.

Spring nursery work, seeding, transplanting, etc., which constitutes an essential phase of a tree improvement program, annually coincides with blossom period of the trees. Thus, as a result of the non-existence of any laborers for the program, the actual breeding phase has been limited. Pro-

cedures, equipment and plant material, which were available and applicable to the program and which at the same time expended a minimum of time and labor, had to be employed when possible. For example, open-pollination seed and progenies were utilized to estimate the breeding value of selections, in preference to the time consuming and more precise method of evaluation with controlled-pollination seed and progenies. Nevertheless, gratifying progress in the tree breeding program has been achieved during the 1947-1952 period.

Exploration studies conducted in 1947 and 1948 produced considerable information of a fundamental nature on breeding and nursery techniques, and resulted in the formulation of project investigations for caragana, pine, spruce, and poplar. A restricted summary of the 1947 to 1952 results follows.

Caragana

Although an important species for shelterbelt purposes in the plains areas of North America and Russia, *Caragana arborescens*, Lam., the Siberian pea-tree, has apparently not been subjected to any previous improvement program. It has proved to be the most reliable and versatile species for general planting on the Canadian prairies over a period of 40 years, and at present constitutes 62 per cent of the annual distribution of the Forest Nursery Station. Favorable results in the control of wind erosion by the use of this species in field shelterbelts have created the demand for increased height to protect larger land areas. Since 1949, research with *C. arborescens* has been concentrated on fertility evaluations of selections, and investigation of the effect of seedtree characteristics upon vigor of progenies. One article has been published[1] on this particular phase of caragana improvement. In this report, later studies have been summarized. For the sake of brevity the simple word 'caragana' has been used as the common name of *C. arborescens*.

During the period 1947 to 1952, *self-* and *open-fertility determinations* were made for more than 400 seedtree selections. These seedtrees were mature, open-pollination plants growing in field shelterbelts on the station, and were selected on the basis of their 'apparent' desirable characteristics, primarily vigor. Three measures of self fertility have been evaluated: i.e. seeds-per-pod-harvested, pods-harvested-per-flower-tripped, and seeds-harvested-per-flower-tripped. These measures have been designated briefly by seeds/pods, pods/flower and seeds/flower respectively. Seeds/pods proved to be a relatively stable characteristic of seedtrees, and provides a measure of pollen and/or ovule viability. Pods/flower, although providing the most convenient measure of self fertility, proved to be relatively inconsistent from year to year. Seeds/flower, on the other hand, has proved to be the more consistent and hence more reliable measure.

Seedtrees which demonstrated a higher degree of open-fertility, are worthy of attention from a plant breeding standpoint. In such cases, it is assumed that the open pollination seed is largely the result of natural cross-pollination, and that the seedtree exhibits a relatively high degree of cross-compatibility. On the same basis, self-sterile seedtrees, which manifested a high degree of open fertility, are of greatest value. A correlation between seed size and self-fertility suggests that selection for large seed size may in practice tend to be selection for low self-fertility.

Size of seed [10 to 40 mg.] and fertility of parental trees had little, if any, influence upon field germination. However, germination capacity of open-pollination seed has varied greatly according to parental source of seed. The

[1] Sci. Agri. 33: 289-298. 1953. W. H. Cram. Parent-seedling characteristics and relationships in *Caragana arborescens*, Lam.

existence of a seed viability problem in C arborescens has been suggested by consistent and negative relationships between germination capacity and rate of germination.

Vigor of 80-day progenies bore no relationship to self-fertility of the parental seedtrees, with vigorous progenies being produced both by self-sterile and highly self fertile seedtrees. However, inferior vigor was displayed by progenies from seedtrees that exhibited a high degree of self-tripping. Thirty-five per cent of 80-day progenies were identified as inferior, on the basis of both seedling height and seedling weight determinations. It would appear that weight determinations may present a rapid and accurate means of "roguing-out" inferior progenies, prior to transplanting the seedlings for a study of mature vigor. Germination and growth of inbred progenies revealed that albinism factors were carried by most selections and also suggested that the so-called "pendulant" habit was a simple recessive character.

Budding appeared to have little merit as a propagation method for C arborescens as the average "catch" with 10 selections was only 10 per cent. The hazard of stock outgrowing the bud and the spiny nature of the material are two further disadvantages of budding. Use of hardwood and softwood cuttings offers a practical means of propagation for caragana. Direct fall planting, of hardwood cuttings from 34 selections, resulted in only 3.5 per cent rooting compared with 19 per cent for cuttings stored overwinter and planted in the spring. An average rooting of 21 per cent was obtained in sand in the greenhouse with softwood cuttings from 18 seedtrees. Seedtrees differed in the rooting capacity of their softwood cuttings, not only with respect to type of cutting and date of collection, but also in their response to hormone and rooting media.

Marked differences in size and viability of seed were noted between seedtrees and dates of harvesting in 1951 and 1952. It was also evident that both size and viability of seed increased up to 16 days prior to natural dehiscence of the pods on the seedtree or for 60 days after date of first bloom.

It would appear that selection and hybridization within the species, should lead to the production of more vigorous and commercial types. Evidence obtained so far would suggest that seedtrees should be selected, not only on the basis of apparent vigor but also for low self-fertility, combined with a high degree of open fertility. Propagation of these selections would permit the establishment of cross-compatible selections in isolated polycross nurseries. The progeny resulting from polycross seed would enable classification of the selections as to combining ability. Selections [clones] which produce superior polycross progenies, would then be established as pairs in natural crossing blocks for the production of vigorous hybrid progenies. Seed collections of C arborescens are solicited from all possible foreign sources in order to maintain genetic diversity.

Pine

The only species of pine under intensive investigation has been the Scots pine [Pinus sylvestris, L.]. To date the breeding work has been confined to the selection of superior seedtrees from six geographic races, which were produced from seed imported from Germany, Russia, Riga, Scotland, Finland, and Aberdeen.

Results to date indicated that Scots pine under prairie conditions may be expected to yield an average of 17.7 seeds per cone following solar extraction. Variations within races, [Scottish from 8 to 46 seeds per cone], would suggest differences between seedtrees for cone size as well as for region adaptability. Average size of Scots pine seed for the 121 seedtrees was 6.5 grams per 1,000

seed [or 69,780 seeds per pound], with a range of 4 4 to 10 1 grams per 1,000 [or 103,000 to 44,900 seeds per pound] The presence of a seed viability problem within *Pinus sylvestris* was suggested by a low average germination capacity of 47 3 per cent Seed from some seedtrees within the Finnish, Russian and Scottish races exhibited only 12 per cent germination. Some seedtrees exhibiting above-average seed yields, seed weight, germination capacity and seedling survival, existed in all races.

Tests of progenies, resulting from the 1947-50 seedcrops of the six geographic races of Scots pine, are in progress.

Spruce

Performance data which were obtained for the 1948 seed-crops of white, Black Hills, and Colorado and Norway spruce seedtrees, have been summarized in Table 14 This initial test revealed a seed viability problem for spruce seed, and seed viability studies were begun.

Table 14.—Summary of Yield, Weight and Seedbed Germination for the 1948 Open-pollination Seed from 94 Seedtrees and 4 Species of Spruce

Spruce Species	Seedtrees Number	Seed Yield (Seeds/Cone)		Seed Weight (gm./1000)		Germination capacity (%)	
		Range	Mean	Range	Mean	Range	Mean
Picea glauca (White)	23	6-53	28	2 1-3·7	2 8	5-25	14 6
P g albertiana (Black Hills)	21	8-37	23	2 1-3 6	2·8	6-33	16 5
P abies (Norway)	14	22-109	69	4 1-6·3	5·2	26-78	50·9
P pungens (Colorado	36	13-123	65	3·8-6 4	4 9	32·74	54 1

The influence of stratification upon germination of spruce seed was investigated in 1950. As the results of this study have previously been reported[2], a summary of the data only has been presented in Table 15. Subsequent studies with seed of Colorado and Norway spruce have indicated that stratification for a 30-day period at 28 to 45° F produced 98 per cent germination. However, seed of white spruce required stratification for 60 days at 40 to 45° F to produce 95 per cent germination.

Table 15.—Comparative Greenhouse and Seedbed Germination of Stratified and Non-stratified Seed of Four Species of Spruce

(apparent germination in first 30 days after sowing)

Spruce Species	Stratified*		Non-stratified†	
	House	Bed	House	Bed
Picea glauca (White)	60·0	56·6	9·0	1·6
P g. albertiana Black Hills)	83·1	65·2	8 1	1·6
P. pungens (Colorado)	35·5	34·8	16·6	1 7
P abies (Norway)	95 1	72·8	62·3	35·5

* Stored in moist sand for 60 days at 34° to 50°F
† Stored dry at room temperatures.

[2] Spruce Seed Viability Dormancy of seed from four species of spruce W H. Cram For Chron. 27 349-357 1951

Results with seed from individual trees reveal that there is a variation in the dormancy period indicating a genetic basis for this trait. The relationship of seed maturity to seed viability was investigated in 1950 for two seed-trees of Colorado spruce, and it was found that seed of Colorado spruce may safely be harvested 11 to 16 days prior to natural dispersal without material loss in viability

Poplar

High rooting capacity is an essential characteristic for all poplar clones utilized for planting on the Canadian prairies Clones, superior for hardiness, vigor and disease resistance, were selected from station plantings of some 200 seedlings, hybrids and species. The rooting capacity of over 60 clones was determined under field conditions in 1948 to 1951 Several clones, especially Volunteer, Brooks No 10, FNS 44-52, demonstrated greater rooting capacity and juvenile vigor than the standard Northwest poplar Differences for field rooting of clones were evident between years Such differences were attributed to environmental factors, such as maturity of the wood, climatic and soil conditions prevailing for the tests. The average response of 17 clones in 1951 would suggest that outdoor storage in soil resulted in superior rooting and greater juvenile vigor than indoor storage in sand. Similarly, thick cuttings were generally superior to thin cuttings.

TREE PHYSIOLOGY

J Wilner, Agricultural Research Officer

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The research work was organized on a definite authorized project basis to include studies of certain physiological factors affecting germination of tree seeds, production of nursery stock and growth and development of mature trees. The nature and purpose of this report require only a brief summary of findings of the exploration work conducted at the Forest Nursery Station for the years 1949-1952 inclusive These follow, under separately indicated headings, for interested members of the general public The meteorological records for the growing seasons covered by the report, indicated that the weather conditions during the 1952 growing season were, in general, conducive to more vigorous and more mature season's growth of woody plants as compared with 1950 and 1949 growing seasons. The 1951 season, on the other hand, was conducive to more vigorous but less mature growth.

I. Study of Factors Affecting Germination of Tree Seeds (Fig. 17(A) and (B)

Effect of stratification treatments The results for four years' studies indicated a trend of generally better germination for prinsepia than for Russian olive. Investigations of weather data for the period covered by this report indicated that the conditions conducive to maturity of wood and seeds appeared to have a more favorable effect on viability of seeds of prinsepia as compared with Russian olive. Stratification treatments at constantly held temperatures of 35° F to 40° F for a period of 1½ to 2 months were generally beneficial to germination of seed of these species as compared with dry storage

Stratification treatments have generally increased the germination of early field-sown seeds of caragana, boxelder, green ash and American elm by about 15 to 20 per cent and have hastened the germination by about 30 to 35 days.

The effects of stratification on speed of germination and germinative capacity of early sown seed was not entirely due to external soil temperatures or moisture conditions but rather to certain internal activation of seeds following after-ripening treatments. Quicker growth of early sown stratified seeds prolonged the growing season and resulted in a generally more vigorous condition of seedlings.

II. Study of Factors Affecting Production of Nursery Stock.

(a) *Effect of certain rotations and intercropping* (Fig 17 (C)) Results of studies indicated a general beneficial effect of the leguminous caragana on growth and development of succeeding crops of boxelder ash and elm. Obtained data failed to indicate any such beneficial effect on seedlings harvested from plots intercropped with crested wheat grass, oats and summerfallow. The four-year study indicated that the shoot/root ratio for caragana was consistently higher as compared with ash, boxelder and elm. This could be due to the additional source of nitrogen that is made available to the caragana by the nitrogen-fixing bacteria in the nodules of its roots. A low concentration of nitrates of about 10 p p m. was shown by chemical analysis of the soils. The study also suggested that the shoot/root ratio of seedlings could be regarded as a more consistent criterion of climatic and soil variation than vigor of seedlings expressed as fresh weight.

(b) *Study of methods of ameliorating conditions of seedlings grown on certain unproductive soils* (Fig 17(D)) Under conditions normally practised at the Forest Nursery Station a gradual deterioration of plants in certain isolated areas of plots is frequently noted. Chemical analysis of the unproductive soils indicated that the growth of plants could be impaired by excessive amounts of salts e.g. nitrates 50 times greater than in normal soils, magnesium 15 times, calcium 10 times, sodium 5 times. The "burning" shrivelled appearance of roots suggested that root injury, possibly as a result of excessive amounts of soluble salts, was the primary reason for the general decline of seedlings.

Various methods were tried to correct these unfavorable soil conditions. These were fertilization, manuring, raising crops of sweet clover, oats, crested wheat grass, application of iron and phosphorus to correct a possible lack of nutrient balance, scraping off surface soil and other cultural treatments such as deep plowing and disking, as well as testing the degree of tolerance to the toxic conditions of the soil of six one-year-old windbreak species of seedlings and cuttings of caragana, green ash, American elm, boxelder, acute willow and cottonwood.

Results have indicated that seedlings of caragana, ash, elm and boxelder were better adapted to the unfavorable soil conditions studied than were cuttings of acute willow and cottonwood. Obtained results have also suggested that the planting of species which are relatively tolerant to the toxic conditions of the soil may be a more practical means of increasing the productivity of such soils than attempting to correct their unfavorable condition by chemical and cultural methods as outlined in this study.

(c) *Effect of certain fungicides in eliminating losses of Scots pine seedlings caused by damping-off fungi* (Figs 17(E)) Studies were conducted to test the effect of certain soil and seed treatments in reducing seedbed losses of Scots pine seedlings caused by damping-off fungi identified as Fusarium spp. The treatments were as follows: formaldehyde, sulphuric and acetic acid soil treatments and arasan, kolodust and spergon seed treatments. These fungicides were applied in a manner and at the rates suggested by various authorities.

The results of four-year studies indicated mainly that none of the tested fungicides may be regarded as a reliable control of the fungi causing damping-off. Nor was there a constancy in relation between the various fungicides and growth of seedlings. The beneficial effect of the formaldehyde treatment which was noted in 1949 was not noted in 1950 and proved to be deleterious in 1951 and 1952. The deleterious effect of acetic acid which was noted in 1952 was not apparent in 1951. The beneficial effect of the sulphuric acid treatment shown in 1952 was not substantiated by the 1951 data.

It would appear however that the incidence of the fungous disease resulting in post-emergence losses of Scots pine seedlings is not of an alarming proportion. Data indicated that damping off fungi accounted for only about 10 per cent of total losses of Scots pine seeds sown in seedbeds at the Forest Nursery Station. Various corrective methods in nursery practices and seed treatments may more than compensate for the losses of these seedlings due to damping-off fungi for which it is difficult to find a reliable control.

(d) *Effect of storage and time of transplanting on survival of broadleaf and evergreen seedlings* (Figs. 17(F) and (G)). The results of studies indicated that winter storage facilities did not adversely affect the survival of broadleaf seedlings of caragana, ash, elm and boxelder when roots were covered with damp moss. Ash appeared to be the least sensitive to variations in storage conditions, boxelder was found to be the most sensitive while caragana and elm were intermediate in reaction. Certain evidence was found to indicate that the difference in survival of broadleaf seedlings with and without moss on roots may have been due to loss in weight, presumably mainly water loss.

Cellar winter storage did adversely affect the survival of evergreens, especially the Scots pine. Spring transplanting from seedbeds as compared with spring transplanting from cellar winter storage generally resulted in a higher survival of transplanted evergreen seedlings.

Little injurious effect was noted from fall transplanting of evergreens as compared with spring planting, especially in the case of spruces. The optimum time for fall transplanting of evergreens varied with season, but data indicated this to be during the latter part of August.

III. Study of Factors Affecting Growth and Development of Mature Tree Species Commonly Grown on the Prairies (Fig. 17 (H))

(a) *Effect of spacing and mulching on drought resistance and maturity of trees species* (1). The results of four years studies indicated that seasonal maturity of twigs of caragana, ash, elm, boxelder and cottonwood was little affected by spacing trees in feet 4 by 4, 8 by 8, 16 by 16, and 4 by 4 with mulch. During the growing season however wider spacing of trees than the usual 4 by 4 feet tended to decrease the water content of growing shoots whereas mulching of 4 by 4 foot belt tended to increase the water content of twigs, i.e. increased the possibility of these shoots escaping injury due to summer-drought. The effect of mulches appeared to be more pronounced during seasons with a subnormal amount of precipitation. During the growing season lower temperatures and somewhat greater amounts of available moisture were found in the surface 6 inches of soil under mulch as compared with no mulch. This would suggest that the increased water content of twigs from trees that were mulched may to a certain extent be due to these factors. Following 10 years of growth no significant differences in vigor were noted between trees planted 8 by 8 feet or 4 by 4 feet mulched as compared with 4 by 4 feet without mulch. Spacing of trees 16 by 16 feet, as compared with 4 by 4 feet,

(1) For experimental procedure etc. relative to this study see paper published in Sci. Agr. 32: 569-573. 1952.

FIG. 88.—Field plots used for tree physiology studies at the Forest Nursery Station, Indian Head, Sask. (A) Effect of certain after-ripening treatments on germination of seeds under greenhouse conditions. (B) Effect of certain after-ripening treatments on speed of germination of seeds of windbreak species in field. (C) Effect of certain [illegible] and tree topping on seasonal growth of windbreak species. (D) Methods of [illegible] of nursery broadleaf seedlings grown on certain [illegible] seasons. (E) Effect of certain fungicides in eliminating losses of nursery evergreen seedlings caused by damping off fungi. (F) Effect of winter storage on survival of broadleaf seedlings. (G) Effect of winter storage and time of transplanting on survival of evergreen seedlings. (H) Factors affecting growth and development of mature tree species commonly grown on the prairies.

resulted in significantly greater height by 2.4 feet, wider spread by 4.3 feet, and greater trunk diameter by 3.2 inches. In view of the proportionately wider open spaces created by spacing trees 16 by 16 feet and the decreased water content of shoots during the growing season, the advisability of wide spacing of trees on the prairies is questioned.

(b) Study of factors affecting winter injury of certain woody plants.[1] Exploratory studies were conducted during the winters of 1949 to 1953 incl., to investigate the importance of certain factors involved in (a) cold resistance of and (b) cold injury to woody twigs taken from plants used for windbreak purposes and fruit production on the Canadian prairies.

(a) *Factors involved in cold resistance.* In view of the concept favored by modern workers that moisture content is an important factor in frost resistance, the quantity of water held by mature twigs of selected plants was primarily studied for its possible association with hardiness. Obtained data revealed that greater maturity of twigs was characterized by lower water content. This characteristic was found to be a persistent physiological trait of woody plants that was not greatly affected by seasonal variations, wide regional distribution,[2] or by the cultural practices of growing trees in beds 4 by 4 feet, 8 by 8 feet, 16 by 16 feet, and 4 by 4 feet with mulch.

Certain evidence was found to support the view held by some workers that greater wood maturity is a factor in resisting winter injury caused by desiccation. In view of this, selecting plants which possess relatively low water content at maturity is suggested as a more practical means of increasing the number of hardy plants on the prairies than resorting to the cultural treatments described in this study.

Estimated bound water of mature twigs of 10 plants, which was retained after about 225 days of outdoor exposure, failed to distinguish the hardier plants more effectively than the total water content of mature twigs that was determined at the beginning of each study. The latter method is apparently a more practical means of distinguishing desirable plants.

(b) *Factors involved in cold injury.* Certain meteorological factors and physiological and morphological plant characters that could affect twigs by their ability to prevent excessive water losses were also investigated. Obtained data indicated that twigs with higher water content contained proportionately more free water and consequently lost more when exposed to certain desiccating outdoor conditions. No evidence was found to show that the hardier plants possess a superior ability to protect themselves from water loss when exposed to desiccating conditions. Obtained data suggested that the hardiness of plants might be due to the ability of living tissues to survive various biological disturbances following desiccation rather than to the extent of dehydration per se.

Desiccation as a factor in winter injury was of prime importance at temperatures above freezing, especially above 41°F., commonly experienced in chinook regions on the prairies. During such mild spells the frozen soil moisture was found to be unavailable to plants. This partly explained the reason for greater injurious effects from mild spells to certain woody twigs than from extreme low temperatures that prevailed during the periods of study.

During the mild spells water had been conducted from adjoining tissues into twigs to overcome drying out. It was noted also that winter desiccation treatments have adversely affected the survival of immature apical tissues previously to the more mature basal tissues of twigs. This could partly be due to the less favorable situation of the apical tissues for utilizing water conducted upwards into twigs as compared with the basal portions.

[1] For certain experimental procedures relative to this study see paper published in Can. Agr. 32:681-690. 1952.

[2] See paper published in Sixth Int. Proc. W. Con. Soc. Hort. 6:49-57. 1953 and 6:58-62. 1953.

No evidence was found to indicate an association between water loss of mature twigs and morphological plant characters such as thickness of cuticle, periderm, cortex, xylem and pith or number of buds and lenticels per twig. Within the limits of the plant material used in this study the hardiness of tips, buds and various portions of the internal tissues appeared to be associated. Bud injury expressed as a ratio of total number of buds originally found on twig, or tip killing expressed as a ratio of total length of twig, are being suggested by these exploratory studies as quantitative criteria to estimate hardiness.

Preliminary findings also suggested that an electrical conductivity test with a Wheatstone bridge could be used as a fairly accurate measure of relative hardiness in closely related species of woody plants.

Conclusions

As previously noted lack of space permitted the presentation of only a brief summary of findings of four years exploration work, of a physiological nature, conducted at this station. As such, the studies are of interest for their positive or negative results. In addition the exploratory investigations can serve as a basis to further revision of the physiological studies being conducted. Some of the projects, such as those involving winter hardiness work, will be extended to include more intensive research. Others, because of certain limitations in staff, etc., may be held in abeyance or considered as completed. It is hoped that with further reorganization and improvement, more gratifying results will be reported in future progress reports on physiological investigations.

PUBLICATIONS ABOUT TREES

If interested you may have for the asking a copy of any of the following publications issued by the Canada Department of Agriculture:

1. Trees for Prairie Farm Planting (FNS Cir. No. 1)
2. Caragana is a Valuable Hedge and Shelterbelt Plant
3. Conditions as to the Preparation of Soil for Tree Planting (Pub. 514)
4. How to Make a Sketch of the Proposed Shelterbelt (Pub. 518)
5. Tree Planting Near Dams and Dugouts (Pub. 629)
6. Irrigating a Prairie Farm Garden (Pub. 657)
7. Tree Fruits Grown in Prairie Orchards (Pub. 780)
8. The Bluestone Treatment for Poplar Posts
9. Pruning, Thinning and Utilizing Trees (Pub. 770)
10. Planning and Planting Field Shelterbelts (Pub. 785)
11. Planting Trees and Hardwood Cuttings on the Canadian Prairies (Pub. 864)
12. Tree Planting Progress Report, 1937-1946.
13. Tree Planting Progress Report, 1947-1952.
14. Preservatives for Farm Fence Posts (being processed)
15. Production of Trees for Prairie Farm Planting (being processed)

For readers especially interested in Tree Breeding and Tree Physiology the following reprints of articles are available:

1. Spruce seed viability: Dormacy of seed from four species of spruce. [For. Chron. 27:349-357. 1951]
2. Parent-seedling characteristics and relationships in Caragana arborescens, Lam. [Sci. Agri. 32:380-402. 1952]
3. The relation of size and storage of cuttings to rooting capacity of poplar clones (mimeo)
4. Vigor of 80-day caragana seedlings (mimeo)
5. Seedcrops from seedtrees of Scots pine races (mimeo)
6. The effects of seasonal and cultural variations on maturity of woody plants commonly grown on the Canadian prairies: [Sci. Agri. 32:568-573. 1952]
7. A study of desiccation in relation to winter injury: [Sci. Agri. 32:651-658. 1952]
8. The importance of maturity in cold resistance of certain woody plants grown under various climatic conditions on the prairies. Repts. of Proc. W.C.S.H. 8:40-47. 1952 and 9:70-81. 1953 (mimeos)
9. A review of the winter hardiness research at the F.N.S. and its application to fruit improvement. 1952 (mimeo)
10. Winter hardiness work conducted at the F.N.S. A co-operative approach to hardiness studies and some preliminary findings. 1953 (mimeo)
11. Effect of storage and time of transplanting on survival of certain broadleaf and evergreen seedlings 1953 (mimeo)
12. A proposed quantative test for winter hardiness of woody plants (mimeo)

Problems and questions about trees and windbreaks are invited. Address:—

The Forest Nursery Station,

INDIAN HEAD, Saskatchewan.

Part of the Sutherland Station, shelterbelts around some plots and buildings. *Star Phoenix Photo.*